



New species of *Mycena* (Basidiomycota, Agaricales) from California

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Abstract

Two new species of *Mycena* are described from California: *Mycena nivicola*, a spring taxon from the High Sierra Nevada and Cascade Ranges is proposed within section *Hygrocyboideae*, and *M. bulliformis* from the Coastal Ranges and Sierra Nevada Foothills is proposed in section *Rubromarginatae*. Both species are fully described, illustrated, and compared with similar and/or closely related taxa.

Key words: fungi, agarics, systematics, taxonomy

Introduction

Our ongoing investigation of California species of *Mycena* (Perry 2002; Perry & Desjardin 1999) has revealed the presence of two previously unnamed taxa: *Mycena nivicola* and *M. bulliformis*, herein proposed as new species. Prior to our investigation, studies in the genus from California were limited to those of A.H. Smith's (1947) monograph of *Mycena* in North America, Harkness & Moore's (1880) Catalogue of Pacific Coast Fungi, those species included in Murrill's (1916) North American Flora and several additional references and field guides (Lincoff 1981; Redhead 1982; Smith *et al.* 1979).

Materials & Methods

In the descriptions that follow, color terms and notations in parentheses are from Kornerup and Wanscher (1978). Spore statistics include; x_m , the arithmetic mean of the spore length by spore width (\pm SD) for n spores measured for a given species; Q , the ratio of spore length to spore width, expressed as a range for all spores measured; Q_m , the mean of all Q values (\pm SD). Geographical regions of California used in the descriptions conform to those described in Hickman (1993). All specimens are deposited in the Harry D. Thiers Herbarium at San Francisco State University (SFSU). Frequently cited collectors are abbreviated as follows: D.E. Desjardin (DED), B.A. Perry (BAP), A.H. Smith (AHS), H.D. Thiers (HDT).

Total genomic DNA was extracted from dried specimens using the E.Z.N.A. Forensic DNA Kit (Omega Bio-Tek, Inc., Norcross, GA) following the manufacturer instructions. PCR protocols followed those outlined in Perry *et al.* (2007). The internal transcribed spacer region (ITS) and nuclear ribosomal large subunit (nLSU) were symmetrically amplified using primers ITS1-F/ITS4 (Gardes & Bruns 1993; White *et al.* 1990) and LROR/LR7 (Moncalvo *et al.* 2000), respectively. Amplification products were cleaned using the Exo-SAPit kit (Affymetrix, Santa Clara, CA), and sent to ELIM Biopharmaceuticals (Hayward, CA) for sequencing. Resulting sequence fragments were edited and assembled in Geneious 8 (Biomatters Limited, Auckland, New Zealand). Pairwise sequence comparisons were performed in PAUP* (Swofford, 2002). All sequences generated as part of this study have been deposited in GenBank (KX513842–KX513849).

Taxonomy

Mycena nivicola B.A. Perry & Desjardin, *sp. nov.* (Figs. 1a, 2)

MycoBank No. 563354

Previous references:

Mycena nivicola B.A. Perry & Desjardin, *nom. prov.*, A Taxonomic Investigation of *Mycena* in California, M.S. Thesis, San Francisco State University, San Francisco, p. 186 (2002).

Mycena nivicola, *nom. inval.*, The Laws Field Guide to the Sierra Nevada, p. 22 (2007).

Mycena nivicola R.M. Davis, R. Sommer & J.A. Menge, *nom. inval.*, Field Guide to Mushrooms of Western North America, p. 179 (2012).

Mycena nivicola B.A. Perry & Desjardin, *nom. prov.*, California Mushrooms, p.198 (2016).

Diagnosis:—Pileus olivaceous to olivaceous brown, with or without yellow tones, lacking a conspicuously white-pruinose surface, covered with a separable gelatinous pellicle. Lacking strong farinaceous taste. Lamellae white to grayish white or pale yellowish white, lacking green coloration. Basidiospores $9.6\text{--}12 \times 5.6\text{--}7.2 \mu\text{m}$. Basidiomes fruiting on wood and woody debris of conifers in association with moisture produced by snow melt, April to June.

Holotype:—UNITED STATES. California: Sierra Co., 3 June 1991, Gold Lake Rd., north of Gold Lake, gregarious on woody debris in deep conifer duff, near melting snow, *DED 5075* (SFSU).



FIGURE 1. a. *Mycena nivicola* (MGW s.n., photo by Michael G. Wood). b. *Mycena bulliformis* (BAP 547, photo by Brian A. Perry) Scale bars = 10 mm.

Description:—*Pileus* 7–32 mm diam., conical to campanulate; the margins incurved in young specimens, pellucid-striate; surface viscid but occasionally becoming dry with exposure (in such cases the surface becoming viscid to tacky when moistened), smooth, glabrous, covered with a separable gelatinous pellicle, hygrophanous, pale yellow with olivaceous tones when young and buried in substrate, becoming olivaceous to olivaceous brown and with or without yellow tones (4–5E3–6), the disc often darker, occasionally developing more yellow tones or rarely becoming reddish olivaceous with moisture loss. *Context* up to 3 mm thick under disc, white to pale yellow or yellowish green. *Lamellae* ascending-adnate, with a small decurrent tooth, close with 1–2 series of lamellulae (25–29 reaching the stipe), moderately broad (up to 2 mm), white to grayish white or pale yellowish white; edges concolorous, not separable as an elastic thread. *Stipe* 40–140 \times 1–5 mm, central, terete, \pm equal, hollow; surface viscid but quickly drying with exposure, shiny or dull, entirely to apically covered with a white pruinosity or canescence, glabrescent below, the base white-tomentose, typically covered with adhering substrate, surface when young pale yellow to lemon yellow (1–3A2–5) centrally, the apex often paler to off-white, becoming dark reddish brown (8E6–8) from the base upwards in age. *Odor* indistinct; *taste* indistinct to mildly farinaceous.

Basidiospores (Fig. 2a) $(9.2\text{--})9.6\text{--}12\text{--}(12.8) \times (5.2\text{--})5.6\text{--}7.2\text{--}(7.6) \mu\text{m}$ [$x_m = 10.9 \pm 0.8 \times 6.2 \pm 0.5 \mu\text{m}$, $Q = 1.4\text{--}2.2$, $Q_m = 1.8 \pm 0.1$, $n = 223$ spores], ellipsoid to broadly ellipsoid, thin-walled, smooth, amyloid. *Basidia* (Fig. 2c) $31\text{--}44\text{--}(58) \times 8.0\text{--}9.6\text{--}(11.2) \mu\text{m}$, 4-spored, clavate, clamped, with sterigmata 3.2–4.4 μm in length; basidioles similar. *Cheilocystidia* (Fig. 2b) $24\text{--}58 \times 5.5\text{--}8.0 \mu\text{m}$, commonly with a clavate to bulbous base and apically extending into one, occasionally two, short to long, tapered, often rather pointed excrescences, more rarely \pm lageniform, the lower portion often with one to several, short, cylindrical excrescences, occasionally lacking excrescences altogether and then \pm clavate, thin-walled, clamped, mixed with basidia, embedded in a gelatinous layer. *Pleurocystidia* absent. *Pileipellis* an ixocutis (Fig. 2e); hyphae 1.2–4.0 μm diam., embedded in a gelatinous layer, thin-walled, clamped (clamps often loop-like), smooth, rarely with a few scattered diverticula; terminal cells typically enlarged somewhat, much branched

and/or covered with cylindrical to slightly coarse excrescences, $1.2\text{--}9.6 \times 1.2\text{--}3.2 \mu\text{m}$. *Hypodermium* composed of inflated cells up to $24.8 \mu\text{m}$ diam., dextrinoid. *Lamellar trama* composed of interwoven hyphae (subregular), dextrinoid. *Stipe cortical hyphae* $1.2\text{--}3.2 \mu\text{m}$ diam., embedded in gelatinous matter, thin-walled, clamped (clamps often loop-like), often appearing coiled, smooth, rarely with a few scattered, cylindrical excrescences; terminal cells (caulocystidia—Fig. 2d) $21\text{--}88 \times 5\text{--}12 \mu\text{m}$, lageniform or with a bulbous to \pm clavate or irregular basal portion, typically extending apically into one, occasionally two, long, tapered excrescences, the lower portion frequently with one to several, relatively short, cylindrical to coarse excrescences, clamped.

Habit, habitat, and known distribution:—Gregarious to subcespitoso on wood or woody debris of conifers (typically buried) near melting snow banks. Common to the *Abies/Pinus* forests of the High Sierra Nevada and Cascade Ranges of California, April to June.

Etymology:—*nivicola* = snow dweller

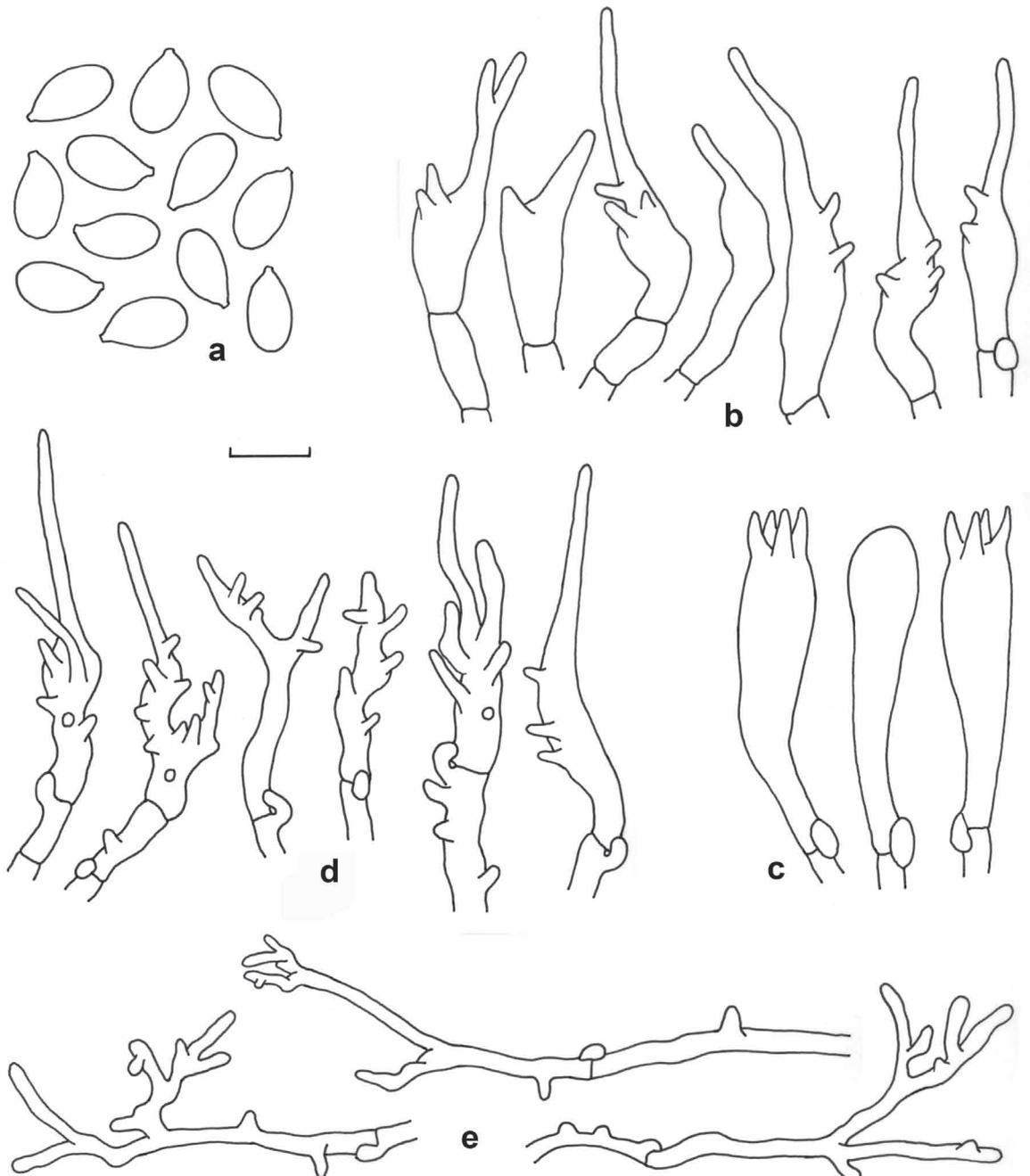


FIGURE 2. Micromorphological features of *Mycena nivicola* (HOLOTYPE—DED 5075). a. Basidiospores. b. Cheilocystidia. c. Basidia and basidiole. d. Caulocystidia. e. Pileipellis hyphae. Scale bar = $10 \mu\text{m}$. Drawings by Brian Perry.

Additional Specimens Examined:—UNITED STATES. California: Amador Co., SR 88, Silver Lake Campground, in soil near melting snow, 18 May 1985, *HDT 49040* (SFSU). Calaveras Co., Poison Creek Picnic Ground, gregarious in humus near melting snowbank, 8 May 1976, *R. Halling 1334* (SFSU). El Dorado Co., Highway 50, Crystal Basin, gregarious to scattered on conifer debris, 6 May 1972, *HDT 28801* (SFSU). Madera Co., Beasore Rd., Bass Lake area, gregarious or subcespitose in woody soil debris near melting snowbanks, 25 April; 1997, *BAP 118* (SFSU). Sierra Co., SR 49, Yuba Pass, gregarious in woody debris near rotting log, in red fir forest, 2 June 1996, *BAP 040* (SFSU); SR 49, Yuba Pass, gregarious or cespitose on woody debris, 4 June 1996, *BAP 046* (SFSU); Weber Lake Rd., approx. 4.5 miles from junction with SR 49 at Yuba Pass, gregarious to subcespitose in woody debris near melting snowbanks, 2 June 1997, *BAP 120* (SFSU); Weber Lake Rd., gregarious in woody debris, June 2001, *M.G. Wood s.n.* (personal collection). Siskiyou Co., Mt. Shasta, gregarious in debris near snow, 29 May 1972, *HDT 28886* (SFSU); Mt. Shasta, Red Fir Flat, gregarious in soil from beneath rotten log, in red fir forest near melting snow, 16 May 1976, *R. Halling 1354* (SFSU). Tuolumne Co., Pinecrest Lake, gregarious on conifer wood near melting snow, 22 May 1970, *HDT 25328* (SFSU).

Comments:—*Mycena nivicola* is herein proposed as a new species of section *Hygrocyboideae* (Fr.) Singer. For years investigators have collected this taxon, commonly identified as *M. griseoviridis* A.H. Sm. (= *M. epipterygia* var. *griseoviridis sensu* Maas Geesteranus 1992), at higher elevations in the Sierra Nevada of California during the spring months. Based upon our investigations, we have chosen to segregate this taxon from *M. griseoviridis* due to macroscopic, microscopic, and habitat differences that exist between the material found in California and that found growing in eastern North America. The holotype specimen of *M. griseoviridis* was collected under *Quercus sp.* during the Fall in Michigan. The California taxon is found only in the Spring growing at high elevations on or near decaying wood of *Abies spp.*, and associated with the moisture produced by melting snow near which it is commonly encountered. In addition to these habitat and seasonal differences, *M. nivicola* differs from *M. griseoviridis* in that *M. nivicola* lacks a “conspicuously white-pruinose” pileus surface, lacks greenish coloration to the lamellae, lacks a strong farinaceous taste and odor, and forms larger basidiospores (see below).

It was suspected at the outset of this investigation that *M. griseoviridis* var. *cascadensis* A.H. Sm., described from Baker Lake, Washington as a summer (spring at higher elevations) fruiter on *Abies* logs, was possibly the same taxon commonly encountered in the Sierra Nevada and Cascade ranges of California. Investigations of the holotype specimen of *M. griseoviridis* (*AHS 15498*; MICH!), several additional collections from Michigan (*AHS 6159*, *AHS 6165*, *AHS 15516*, *HDT 512*; all at MICH), numerous collections of the California taxon, and the holotype specimen of *M. griseoviridis* var. *cascadensis* (*AHS 16656*; MICH!) revealed that with the exception of spore size, the micromorphology of all three taxa is much too similar to be useful in delimiting these species. *Mycena griseoviridis* has smaller spores overall ($x_m = 9.5 \times 6.0 \mu\text{m}$) than does *M. nivicola* ($x_m = 10.9 \times 6.2 \mu\text{m}$). The holotype specimen of *M. griseoviridis* var. *cascadensis* has spores within the same size range as the type variety. Additionally, Smith’s (1947) description of *M. griseoviridis* var. *cascadensis* indicates that this taxon has a more gray to yellow colored pileus than *M. nivicola*, and lacks the reddish brown coloration that develops on the stipe base in mature basidiomes of *M. nivicola*. Until further specimens from Baker Lake, Washington matching the protologue of *M. griseoviridis* var. *cascadensis* are collected and studied, we recognize the latter taxon as distinct from *M. nivicola*.

Pairwise comparison of ITS sequence data for the holotype collection of *M. nivicola* (*KX513843*) with sequences of *Mycena epipterygia* (of which *M. griseoviridis* is considered a variety by Maas Geesteranus) from California, Washington, Tennessee, British Columbia, Italy and Sweden (*KX513842*, *KP406534*, *FJ596884*, *DQ384586*, *EF530946*, *EU486451*, *HQ604771*, *HQ604772*, *KP454034*, *HM240533*, *JF908458*, *JF908460*, *JF908468*, *AY781261*, *GU234008*), indicate 5.6%–6.8% difference between this taxon and *M. nivicola* in aligned, overlapping regions. However, among the ITS sequences of those collections identified as *M. epipterygia*, pairwise comparisons recover differences of 0%–10.3%, suggesting that the taxon is highly variable for this marker and likely represents multiple cryptic taxa at the species level. Pairwise comparison of the more conserved nLSU region for an additional *M. nivicola* specimen (*KX13847*) with sequences of *M. epipterygia* specimens from California and Germany (*KX13846*, *AY207249*) indicate 0.7–3.6% difference between aligned, overlapping regions, respectively. Comparison of nLSU sequences from the two *M. epipterygia* specimens reveal a difference of only 0.3%.

Mycena bulliformis B.A. Perry & Desjardin, *sp. nov.* (Figs. 1b, 3)

Mycobank No. 563355

Previous references:

Mycena bulliformis B.A. Perry & Desjardin, *nom. prov.*, A Taxonomic Investigation of *Mycena* in California, M.S. Thesis, San Francisco State University, San Francisco, p. 130 (2002).

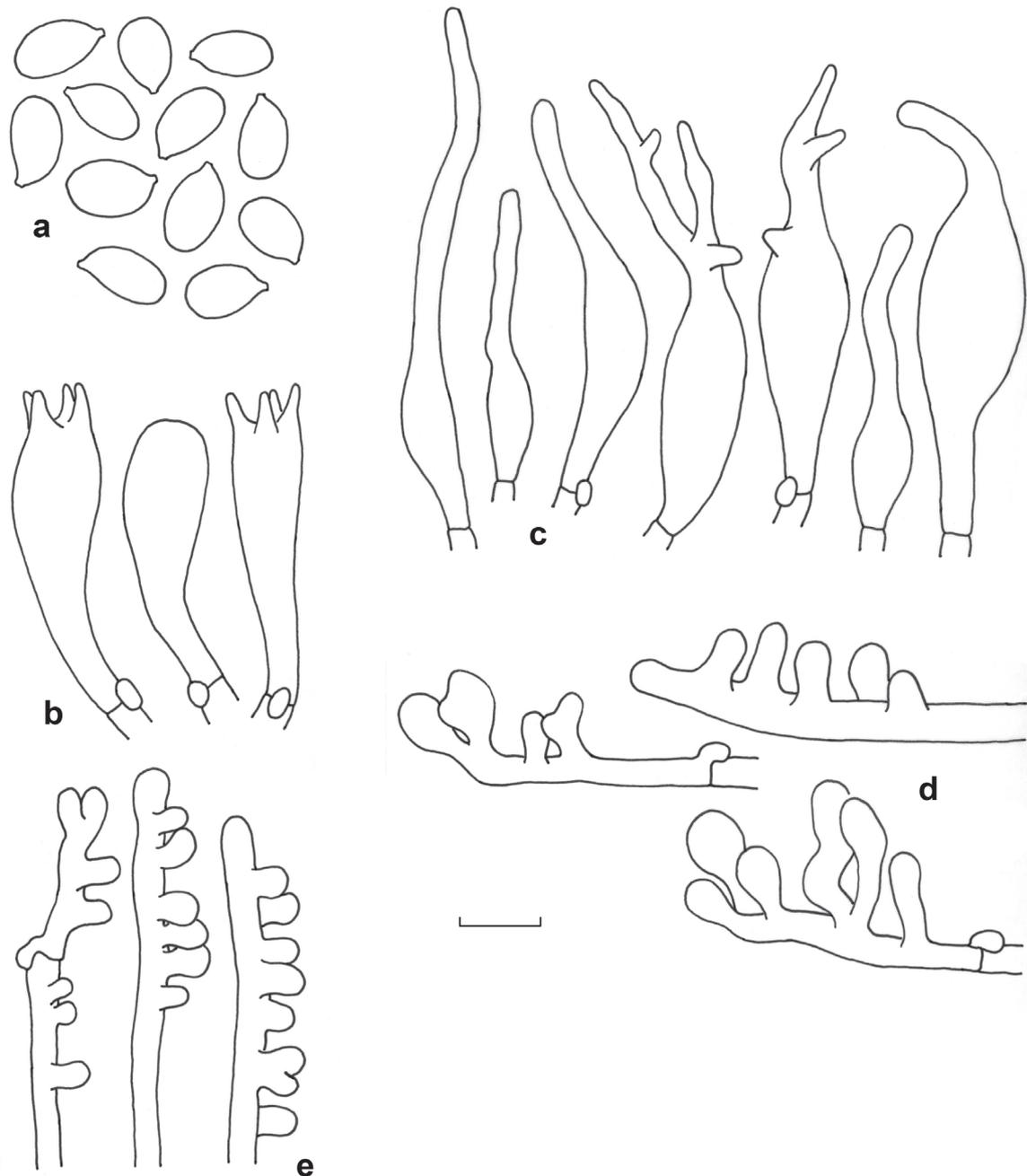


FIGURE 3. Micromorphological features of *Mycena bulliformis* (HOLOTYPE–DED 5614). a. Basidiospores. b. Basidia and basidiole. c. Cheilocystidia. d. Pileipellis hyphae. e. Stipitipellis hyphae. Scale bar = 10 μ m. Drawings by Brian A. Perry.

Diagnosis:—Pileus violaceous brown to reddish brown or grayish red, often nearly grayish pink in age, lacking yellow coloration. Stipe pink to pinkish gray when young, lacking yellow coloration. Pileipellis and stipe cortical hyphae ornamented with coarse, inflated excrescences. Cheilocystidia subcylindrical to irregular-lageniform or fusoid-ventricose in shape, giving rise apically to one or more, cylindrical to sinuous excrescences.

Holotype:—UNITED STATES. California: Marin Co., Mt. Tamalpais State Park, Benstein Trail, Rock Springs area, cespitose on the bark of living *Pseudotsuga menziesii*, 22 December 1992, *D. E. Desjardin 5614* (SFSU).

Description:—*Pileus* (Fig. 1b) 10–25 mm diam., obtusely conical to paraboloid, expanding with age; the margin slightly inflexed initially, edges crisped and occasionally eroding or splitting with age, pellucid-striate when moist, striate to sulcate in age; surface dull, dry, covered with a hoary bloom when fresh, glabrescent; the disc violet-brown

(10–11F5–7) to deep grayish red or grayish violet (12–13E5–6) initially, becoming more grayish to brownish red/violet with age, the margin paler, grayish red (9C3) to pale reddish brown (9D5–6), becoming grayish pink with moisture loss. *Context* thin, up to 1 mm thick, white. *Lamellae* ascending-adnate, with or without a short decurrent tooth, subdistant with 1 or more series of lamellulae (18–20 reaching the stipe), narrow to moderately broad (up to 2.5 mm); white to buff, often with pink tones; edges violet to violet-brown (11–12D6), rarely concolorous with lamellae sides. *Stipe* 25–72 × 1.5–3 mm, central, terete to somewhat flattened and once-cleft, hollow; surface dull to polished, dry, the apex white-pruinose initially, glabrescent; white with pink tones or pinkish gray (9–11C3) overall when young, in age the apex remaining pinkish gray with the base becoming gray to brownish gray; the base sparsely covered with short, white fibrils. *Odor* mild or musty. *Taste* mild to unpleasant.

Basidiospores (Fig. 3a) 9.6–12.2(–12.6) × (5.6–)6.2–7.7(–8.1) μm [$x_m = 11.0 \pm 0.9 \times 6.8 \pm 0.5$ μm, $Q = 1.4–1.9$, $Q_m = 1.6 \pm 0.1$, $n = 50$ spores], ellipsoid to broadly ellipsoid, smooth, thin-walled, amyloid. *Basidia* (Fig. 3b) 27–37 × 7.2–9.6(–11.3) μm, clavate, 4-spored, clamped, sterigmata up to 8.8 μm in length; basidioles clavate. *Cheilocystidia* (Fig. 3c) 24–59 × 7–16 μm, subcylindrical, irregular-lageniform or fusoid-ventricose, apically giving rise to one or several, short to long, cylindrical to sinuous, simple or rarely branched excrescences, 4.0–41.6 × 2.4–4.0 μm; thin-walled, clamped, filled with brownish violet, granular contents when mounted in water or Melzer's reagent; forming a sterile lamellar edge. *Pleurocystidia* absent. *Pileipellis* a cutis (Fig. 3d); hyphae 2.4–4.8(–8.1) μm diam., clamped, thin-walled, smooth or covered with coarse, inflated or more rarely cylindrical, often furcate excrescences, 2.0–15.2 (–23) × 1.6–6.4 μm diam.; hyphae filled with copious oily droplets, or with reddish brown, granular contents when mounted in water or Melzer's reagent. *Hypodermium* composed of inflated, elongate cells, brownish vivescent in Melzer's reagent. *Pileus and lamellar trama* similar to hypodermium. *Stipe tissues* monomitic, parallel, brownish vivescent in Melzer's reagent. *Stipe cortical hyphae* (Fig. 3e) 2.0–3.2 μm diam., clamped, thin-walled, covered with scattered to densely spaced, lump-like to strikingly inflated, coarse excrescences, 3.2–22 × 3.2–9.6 μm; terminal cells repent, up to 8.8 μm diam., covered with excrescences similar to those of the cortical hyphae.

Habit, habitat, and known distribution:—Cespitose on bark and wood of standing and dead *Pseudotsuga menziesii* (Mirbel) Franco, and possibly that of *Arctostaphylos glandulosa* Eastw., North and Central Coast Ranges and the Sierra Nevada Foothills, November to January.

Etymology:—*bulliformis*—in reference to the large, rather coarse, bulliform excrescences of the pileipellis and stipe cortical hyphae

Additional Specimens Examined:—UNITED STATES. California: Marin Co., Mt. Tamalpais State Park, Simmons Summit south, under *Arctostaphylos glandulosa*, possibly on buried wood, 13 December 1996, *J. R. Blair 270* (SFSU). Mendocino Co., Jackson State Demonstration Forest, junction of roads 408 and 409, cespitose on bark of *Pseudotsuga menziesii*, 23 November 2002, *DED 7532* (SFSU); Jackson State Demonstration Forest, Mendocino Woodlands Camp, cespitose on bark of *Pseudotsuga menziesii*, 11 November 2007, *BAP 547* (SFSU).

Comments:—*Mycena bulliformis* belongs in sect. *Rubromarginatae* Singer ex. Maas Geest. due to the violaceous lamellar edges, red to violaceous tones on the pileus, and lack of latex. Within North America, *M. bulliformis* is most likely confused with *M. rubromarginata* (Fr.: Fr.) P. Kumm. *sensu* Maas Geesteranus (1986, 1992), and within California, *M. purpureofusca* (Peck) Sacc. *Mycena rubromarginata* has been reported from the bark of spruce and fir throughout northern North America and as far south as Oregon in the west and North Carolina in the east (Smith, 1947). Micromorphologically, *M. bulliformis* resembles *M. rubromarginata* in the shape of its cheilocystidia, but differs in the shape and size of both the pileipellis and stipe cortical hyphae excrescences. *Mycena rubromarginata* is characterized by more or less narrow, cylindrical, and very long pileipellis excrescences (up to 36 μm; Maas Geesteranus 1986, 1992), and short, cylindrical stipe cortical hyphae excrescences, whereas *M. bulliformis* has pileipellis and stipe cortical hyphae excrescences that are generally shorter and coarser and/or inflated (2.0–15.2 (–23) 1.6–6.4 μm diam.). In addition, *M. bulliformis* has some pileipellis hyphae that are smooth, a condition not reported in *M. rubromarginata*. *Mycena purpureofusca*, in contrast, is typically much more purple to violaceous in pileus, stipe and lamellar edge coloration than is *M. bulliformis*, often has a raphanoid odor, and can be further distinguished by pileipellis and stipe cortical hyphae that are embedded in gelatinous matter.

Additional species of section *Rubromarginatae* that superficially resemble *M. bulliformis* include, *M. seynii* Quél., *M. seynesiella* Malençon, and *M. renati* Quél. Microscopically, *M. bulliformis* differs from *M. seynii* in having slightly shorter spores [10.5–15(–16) × 6–7.5(–8) μm in *M. seynii*; Robich 2003], and cheilocystidia that are typically irregular-lageniform in shape or with more than one long, coarse excrescence. The typical cheilocystidia in *M. seynii* are subcylindrical to clavate or subfusiform, and with or without one or more shorter, coarse excrescences (Kühner 1938, Maas Geesteranus 1986, 1992, Robich 2003). Macromorphologically, *M. bulliformis* can be distinguished from *M. seynii* by the lack of yellow tones that often develop on the pileus of *M. seynii*, as well the lack of a rooting stipe, and

the lack of a dense coating of whitish fibrils or tomentum on the lower portion of the stipe that is common in *M. seynii*. Maas Geesteranus (1986, 1992) reported the presence of “watery white to dingy whitish” coloration on the lower stipe in *M. seynii*, a condition that has not been observed in *M. bulliformis*. Moreover, *M. bulliformis* is not known to grow on the fallen cones or wood of *Pinus spp.*, which is reported to be the common habit of *M. seynii* (Kühner 1938, Maas Geesteranus 1986, 1992, Robich 2003). *Mycena seynesiella* can be differentiated from *M. bulliformis* by the presence of a removable, gelatinous pellicle in the former species, as well as a chlorine-like or nitrous-like odor, and the presence of copper and pale honey tones that develop on the pileus and stipe respectively. Neither *M. seynii* nor *M. seynesiella* have been reported from North America. *Mycena renati* differs from *M. bulliformis* in forming differently shaped cheilocystidia, has smaller basidiospores (8.8–10.4(–10.8) × 4.8–5.6 µm), and in forming a distinctly yellow stipe (Maas Geesteranus 1992, Robich 2003). *Mycena renati* was reported from decayed conifer wood in North America, including California, by Smith (1947, as *Mycena rubromarginata* var. *laracis* Smith = *Mycena elegantula* Peck). However, Smith’s concept of this taxon has proved to include several distinct species (see Perry & Desjardin 1999), and to our knowledge *M. renati* has not been documented from California.

Pairwise comparison of ITS sequence data from a single collection of *M. bulliformis* (KX513844) with sequences of *M. rubromarginata* from Austria (JF908430), Denmark (KX513845), Norway (JQ358810), and British Columbia (EF530939, KP454009, HM240536, HM240537) indicate 4.6%–5.0% difference between aligned, overlapping regions, while comparison of the sequences of *M. rubromarginata* indicate a difference of only 0–0.35% for the same marker. Comparison of sequence data for the more conserved nLSU from the same *M. bulliformis* collection (KX513848) with sequence data of *M. rubromarginata* from Germany (AY20745) and Denmark (KX513849), indicate a 1.1% difference between aligned, overlapping regions. In contrast, the sequences of *M. rubromarginata* from Germany and Denmark are 100% identical throughout all overlapping regions. Similar pairwise comparisons of ITS sequence data for *M. bulliformis* with existing sequences of *M. purpureofusca* from British Columbia (HQ604763, HQ604764, HQ604765, HQ604766, HQ604767) and Norway (JQ358809), indicate differences of 1.7–1.9% between aligned, overlapping regions. Comparison of the sequence data for these same *M. purpureofusca* collections indicates pairwise differences of only 0.0–0.17%.

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